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IS 4825 (1982): Liquid-in-Glass Solid-Stem Reference Thermometers [CHD 10: Glassware]

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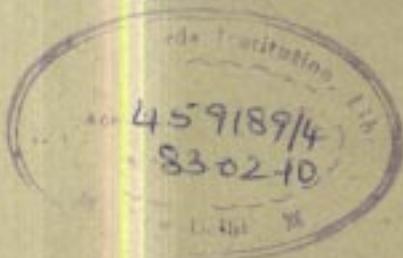
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Indian Standard

SPECIFICATION FOR LIQUID-IN-GLASS SOLID-STEM REFERENCE THERMOMETERS

(*First Revision*)

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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Indian Standard

SPECIFICATION FOR LIQUID-IN-GLASS SOLID-STEM REFERENCE THERMOMETERS

(First Revision)

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(Continued on page 14)

*Indian Standard*SPECIFICATION FOR LIQUID-IN-GLASS
SOLID-STEM REFERENCE THERMOMETERS*(First Revision)***0. FOREWORD**

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 28 January 1982, after the draft finalized by the Laboratoryware and Related Apparatus Sectional Committee had been approved by the Chemical Division Council.

0.2 This standard was first published in 1968 under the title 'Specification for laboratory and reference thermometers'. In view of the experience gained during the years in the fabrication of thermometers specified in it, the Committee responsible for the preparation of the standard decided to revise it restricting its scope to reference thermometers meant for use in calibrating liquid-in-glass thermometers. In this revision, accordingly, thermometers of partial immersion type which are not used for reference purposes, have been dropped and the dimensions of thermometers have been modified.

0.3 The Committee, while finalizing this standard, envisaged preparation of a standard covering precision thermometers for use in research and testing laboratories where a high degree of precision is required.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard specifies requirements for a basic series of liquid-in-glass solid-stem reference thermometers meant for use in calibration of thermometers.

*Rules for rounding off numerical values (revised).

2. TERMINOLOGY

2.0 For the purpose of this standard, the definitions given in IS: 2627-1979*, in addition to the following, shall apply.

2.1 Schedule Mark — The number corresponding to the serially arranged thermometers in col 1 of Table 1.

3. TEMPERATURE SCALE

3.1 The thermometers shall be graduated in accordance with the Celsius scale as defined in the current definition of the International Practical Temperature Scale (IPTS) adopted by the Conference generale des poids et mesures, and in accordance with the International System of Units (SI).

4. IMMERSION

4.1 The thermometer shall be adjusted for use at total immersion, for example, the reading shall be correct when the thermometer is so immersed that the top of the liquid column is in the same plane as the surface of the medium, the temperature of which is required to be measured.

5. GLASS

5.0 The thermometers shall be made of suitable thermometric glass (see IS: 4610-1968†) so selected and processed that the finished thermometers show the following characteristics.

5.1 Stress in the glass of the bulb and capillary stem shall be reduced to a level sufficient to minimize the possibility of fracture due to thermal or mechanical shock.

5.2 The bulb glass shall be stabilized by a suitable heat treatment to ensure that the accuracy requirements of **10.1** and **10.3** are met.

5.3 The legibility of the reading shall not be impaired by devitrification or clouding.

5.4 The image of the meniscus shall be distorted as little as possible by defects or impurities in the glass.

6. LIQUID FILLING

6.1 Mercury shall be used as liquid filling, except for thermometers with a scale extending below -38°C for which the eutectic alloy of mercury and thallium (8.5 percent thallium by mass) shall be used. The liquid filling shall be free from any contamination likely to interfere with the proper functioning of the thermometer.

*Glossary of terms relating to liquid-in-glass thermometers (*first revision*).

†Specification for glass tubes for general purpose and reference thermometers.

7. GAS FILLING

7.1 Thermometers having an upper nominal limit above 100°C shall be filled with a dry, inert gas. The pressure of the gas shall be high enough to raise the boiling point of the liquid filling sufficiently to minimize vaporization.

8. CONSTRUCTION

8.1 Patterns — The thermometers shall be of 3 patterns, namely, Patterns A, B and C. The thermometers shall be straight and their external cross-section approximately circular (see Fig. 1).

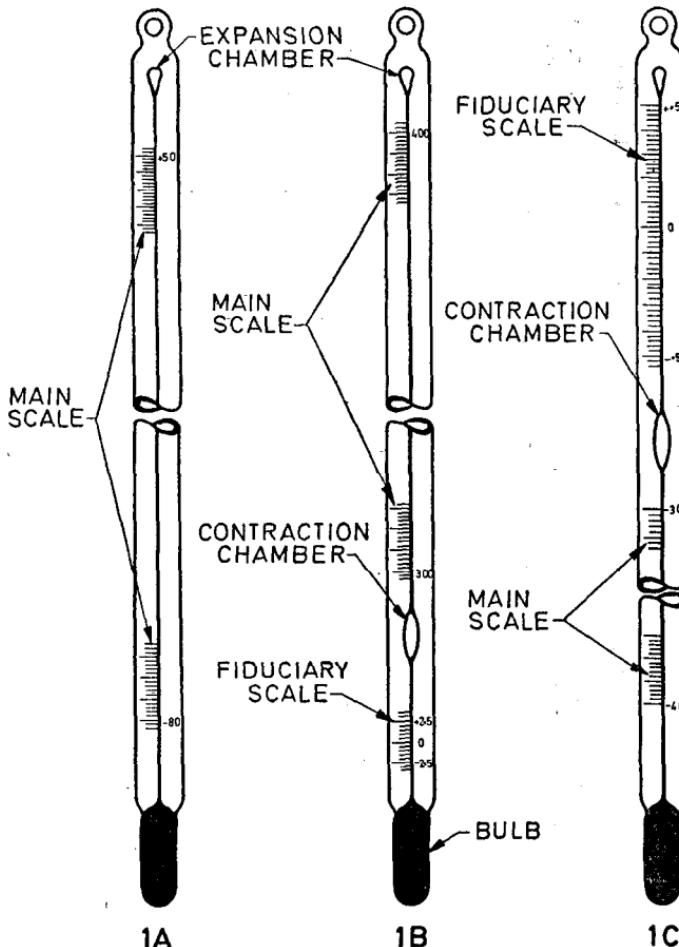


FIG. 1 PATTERNS OF REFERENCE THERMOMETERS

TABLE 1 SCALES AND DIMENSIONS OF LIQUID-IN-GLASS SOLID-STEM
REFERENCE THERMOMETERS

(*Clauses 2.1, 8.7, 9.1.1 and 10.1*)

- i) Diameter of stem 5.5 to 8 mm
- ii) Bulb length 15 to 40 mm
- iii) Diameter of bulb Not more than that of stem

SCHE- DULE MARK	MAIN SCALE	SCALE INTERVAL	SCALE ERROR (Max)	LONGER LINES AT EACH	OVERALL LENGTH (Max)	LENGTH OF MAIN SCALE (Min)	AUXILIARY SCALE	DISTANCE FROM THE BOTTEM OF THE BULB TO THE START OF THE MAIN SCALE, Min	PATTERN (see FIG. 1)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	°C	°C	°C	°C	mm	mm	m°C	mm	
1	— 40 to — 30	0·05	0·2	0·1	500	280	— 0·5 to + 0·5	85	C
2	— 30 to — 20	0·05	0·2	0·1	500	280	— 0·5 to + 0·5	85	C
3	— 20 to — 10	0·05	0·2	0·1	500	280	— 0·5 to + 0·5	85	C
4	— 10 to 0	0·05	0·2	0·1	500	280	—	85	A
5	0 to 10	0·02	0·1	0·1	500	280	—	85	A
6	10 to 20	0·02	0·1	0·1	500	280	— 0·5 to + 0·5	85	B
7	20 to 30	0·02	0·1	0·1	500	280	— 0·5 to + 0·5	85	B
8	30 to 40	0·02	0·1	0·1	500	280	— 0·5 to + 0·5	85	B
9	40 to 50	0·02	0·1	0·1	500	280	— 0·5 to + 0·5	85	B
10	50 to 60	0·02	0·1	0·1	500	280	— 0·5 to + 0·5	85	B
11	60 to 70	0·02	0·2	0·1	500	280	— 0·5 to + 0·5	85	B
12	70 to 80	0·02	0·2	0·1	500	280	— 0·5 to + 0·5	85	B
13	80 to 90	0·02	0·2	0·1	500	280	— 0·5 to + 0·5	85	B

14	90 to 100	0.02	0.2	0.1	500	280	- 0.5 to + 0.5	85	B
15	100 to 110	0.05	0.2	0.1	350	120	- 0.5 to + 0.5	85	B
16	110 to 120	0.05	0.2	0.1	350	120	- 0.5 to + 0.5	85	B
17	120 to 130	0.05	0.2	0.1	350	120	- 0.5 to + 0.5	85	B
18	130 to 140	0.05	0.2	0.1	350	120	- 0.5 to + 0.5	85	B
19	140 to 150	0.05	0.2	0.1	350	120	- 0.5 to + 0.5	85	B
20	- 40 to + 10	0.1	0.2	0.5	450	280	—	85	A
21	0 to 50	0.1	0.2	0.5	450	280	—	85	A
22	50 to 100	0.1	0.3	0.5	450	280	- 0.5 to + 0.5	85	B
23	100 to 150	0.1	0.4	0.5	450	280	- 0.5 to + 0.5	85	B
24	150 to 200	0.1	0.4	0.5	450	280	- 0.5 to + 0.5	85	B
25	200 to 250	0.1	0.5	0.5	450	280	- 0.5 to + 0.5	85	B
26	250 to 300	0.1	0.5	0.2	450	280	- 0.5 to + 0.5	85	B
27	- 80 to + 50	0.5	1.0	1.0	400	210	—	85	A
28	300 to 400	0.5	2.0	1.0	300	120	- 0.5 to + 0.5	85	B
29	400 to 500	0.5	2.5	1.0	300	120	- 0.5 to + 0.5	85	B

8.2 Top Finish — The top of the thermometer should preferably be finished with a glass ring, the diameter of which shall not exceed that of the stem. Alternatively, a plain or button finish may be provided, and this may be preferred for thermometers having upper limit of the main scale above 300°C.

8.3 Capillary Tube

8.3.1 The inside of the capillary tube shall be smooth.

8.3.2 The cross-sectional area of the bore shall not show variations greater than 10 percent from the average and the bore shall be wide enough to ensure that jumping of the meniscus does not exceed one-fifth of the graduation interval.

8.3.3 If the capillary tube incorporates an enamel backing, it shall be so positioned that it lies behind the liquid column when the latter is viewed in alignment with the right-hand ends of the shortest scale lines and also when viewed in alignment with the left-hand ends of all of the scale line.

8.4 Expansion Volume

8.4.1 An expansion volume shall be provided at the top of the capillary tube.

NOTE — Overheating is liable to change the zero point of a thermometer and a redetermination will be necessary if it occurs.

8.4.2 The volume above the scale shall be at least equivalent to that occupied by an interval of 80°C of the scale.

8.4.3 This volume should preferably consist of an expansion chamber, and this chamber shall be pear-shaped with the hemisphere at the top.

8.4.4 For thermometers having upper limit of the main scale below 50°C, the lower end of the expansion chamber shall be so elongated as to avoid the risk of a break in the mercury column during storage at ambient temperature.

8.5 Contraction Chamber — Thermometers having a lower limit of the main scale above 0°C or upper limit of the main scale below 0°C shall be provided with a contraction chamber to allow for the inclusion of an auxiliary scale (*see* Fig. 1 Patterns B and C). The contraction chamber shall be as elongated and narrow as possible to avoid a break in the mercury column at ambient temperature.

8.6 Position of Chambers — No enlargement of the bore shall be so located as to produce any variation greater than that permitted in 8.3 in the cross-section of the capillary tube in the scale portion. The distance from the top of the contraction chamber to the first scale line of the scale

immediately above it shall be not less than 15 mm, except that for thermometers having lower limit of the main scale above 150°C, this distance shall be not less than 25 mm.

8.7 Dimensions — The dimensions of the thermometers shall be as given in Table 1 and Fig. 1.

9. GRADUATION AND FIGURING

9.1 Graduations

9.1.1 The scale ranges and scale intervals of the thermometers shall be as given in Table 1.

9.1.2 The scale lines shall be clearly and durably marked. They shall be equally spaced and shall be of uniform thickness which shall not exceed 0.12 mm. The lines shall be at right angles to the axis of the thermometer.

9.1.3 When the thermometer is held in a vertical position and viewed from the front, the left-hand ends of all the scale lines shall lie on an imaginary vertical line. When the thermometer is so viewed that the right-hand ends of the shortest scale lines align with the left-hand side of the bore, the medium and longer lines referred to shall extend across the bore towards the right.

9.1.4 The length of the short scale lines shall be approximately 1 mm. The medium and long lines shall be suitably extended as prescribed in 8.1.2 of IS : 8787-1977*.

9.2 Sequence of Graduations

9.2.0 General — The arrangement of the scale lines shall be as follows.

9.2.1 On thermometers where the smallest scale division is 0.1°C:

- every tenth scale line shall be a long line;
- there shall be a medium line midway between two consecutive long lines;
- there shall be four short lines; equally spaced between consecutive medium and long lines (see Fig. 2).

9.2.2 On thermometers where the smallest scale division is 0.02°C:

- every fifth scale line shall be a long line;
- there shall be four short lines equally spaced between two consecutive long lines (see Fig. 2).

*Principles of design, construction and use of liquid-in-glass thermometers.

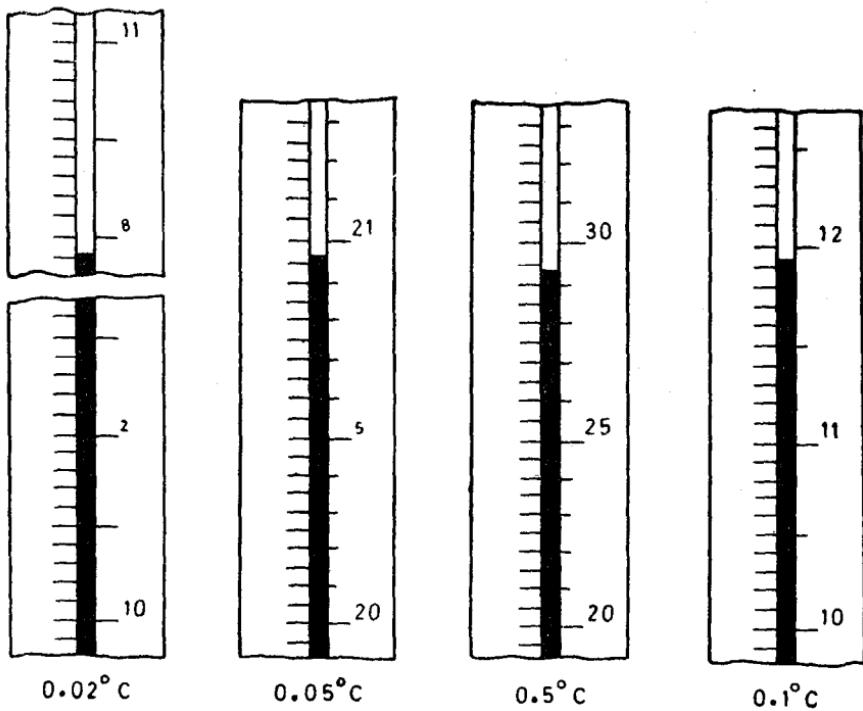


FIG. 2 GRADUATION AND FIGURING OF THERMOMETERS

9.2.3 On thermometers where the smallest scale division is 0.05 or 0.5°C :

- every tenth scale line shall be a long line;
- there shall be four medium lines equally spaced between two consecutive long lines;
- there shall be one short line between two consecutive medium lines or between consecutive medium and long lines (*see Fig. 2*).

9.3 Figuring

9.3.1 The figures shall be placed slightly to the left or to the right of the line to which they refer, as preferred, in such a way that an extension of the line would bisect them or pass immediately under them. The figures may be placed parallel to, or at right angles, to the axis of the thermometer, as preferred.

9.3.2 Every tenth scale line shall be figured and the series of figures shall be in accordance with the smallest scale division as follows:

<i>Smallest Scale Division, °C</i>	<i>Series of Figures, °C</i>
0·1	1, 2, 3, , etc
0·02	0·2, 0·4, 0·6, , etc
0·05	0·5, 1·0, 1·5, , etc
0·5	5, 10, 15, , etc

9.3.3 The auxiliary scale shall be figured at 0°C. Scale lines at 0°C or 10° or 100°C may be emphasized (for example, by full figuring if either the first or first and second digits are omitted at intermediate scale lines).

9.3.4 The pigment filling shall remain in the scale lines, figures and inscriptions under normal conditions of use and under such other special conditions as may be specified between the purchaser and the vendor or manufacturer.

9.3.5 Each end of the scale shall be extended by a minimum of five divisions beyond the nominal limits of the scale.

9.3.6 All negative numbers may be indicated by minus signs, for example, -5 or $\bar{5}$ as preferred, so placed that they are not liable to be confused with the scale line, or other marking.

10. ACCURACY

10.0 When tested in accordance with the methods prescribed in IS : 6274-1971*, the scale and interval errors shall not exceed the limits prescribed in **10.1** and **10.2**.

10.1 Scale Error — The maximum permissible scale error shall not be more than the limit prescribed in col 4 of Table 1, when the thermometer is in a vertical position and at the prevailing atmospheric pressure.

10.2 Interval Error — The absolute value of the algebraic difference between the errors at any two points, which are not more than 50 divisions apart, shall not be greater than one scale division.

10.3 Change in Zero — When a thermometer is maintained over a period of 24 h at the highest temperature of the scale, the change in the zero point, determined by the method described in Appendix A, shall not exceed one scale division, and the scale error shall remain within the limit prescribed in col 4 of Table 1.

*Method of calibrating liquid-in-glass thermometers.

11. MARKING AND PACKING

11.1 The following inscriptions shall be durably and legibly marked on the thermometers:

- a) temperature scale indication: the official symbol ‘°C’, or an abbreviation of the name Celsius (for example, ‘C’);
- b) gas filling, if any, for example, ‘nitrogen filled’, ‘vacuous’, or a suitable abbreviation;
- c) manufacturer’s identification or serial number (where required);
- d) vendor’s and/or maker’s name or recognized trade-mark; and
- e) schedule mark, for example, 7 — IS : 4825 at the back of the thermometer.

11.1.1 The thermometers may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

11.2 **Packing** — Each thermometer shall be packed suitably in protective cases to avoid breakage in transit.

12. TESTING AND INSPECTION

12.1 Each thermometer shall individually comply with all the requirements of this standard.

APPENDIX A*(Clause 10.3)***METHOD OF DETERMINING CHANGE IN ZERO****A-1. PROCEDURE**

A-1.1 Heat the thermometer, immersed in a test bath, to a temperature equal to its highest reading and keep it at this temperature for 5 min. Allow the thermometer to cool either naturally in still air or slowly in the test bath (at a reproducible rate) to 20°C above ambient temperature or to 50°C, whichever is the lower, and then determine the zero. If natural cooling is used, the zero should be determined within 1 h. Heat the thermometer again to a temperature equal to its highest reading, keep it at this temperature for 24 h, allow the thermometer to cool to one of the two temperatures referred to above, at the same rate as at the start of the test, and redetermine the zero under the same conditions as before.

(*Continued from page 2*)

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1381 (Part II)-1977 Boiling flasks: Part II Flasks with conical ground socket (*first revision*)
1388-1959 Reagent bottles
1541-1978 Glass filter funnels (*first revision*)
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1672-1967 Floating dairy thermometers (*first revision*)
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2618-1963 Test-tubes
2619-1971 Glass beakers (*first revision*)
2620-1963 Distilling flasks
2626-1972 Petri dishes (*first revision*)
2627-1979 Glossary of terms relating to liquid-in-glass thermometers (*first revision*)
2836-1974 Methods of test and quality requirements for porcelain, laboratory apparatus (*first revision*)
2837 (Part I)-1975 Porcelain crucibles and basins: Part I Crucibles (*first revision*)
2837 (Part II)-1977 Porcelain crucibles and basins: Part II Basins (*first revision*)
3055 (Part I)-1977 Clinical thermometers: Part I Solid-stem type (*first revision*)
3104 (Part I)-1982 Density hydrometers: Part I Requirements (*first revision*)
3104 (Part II)-1982 Density hydrometers: Part II Methods of test and use (*first revision*)
3432-1965 Clay pipe triangles
3608-1966 Glass alcoholometers
3936-1966 Porcelain mortars and pestles
3953-1966 High temperature ceramic combustion boats
3990-1967 High temperature ceramic combustion tubes
4161-1967 Nessler cylinders
4162-1967 Graduated pipettes
4426-1967 Methods of sampling laboratory glasswares and medical glass instruments
4529-1968 Glass tubes for medical thermometers

IS :

4610-1968 Glass tubes for general purpose and reference thermometers
5009-1968 Buchner funnels
5011-1968 Gooch crucibles
5165-1969 Interchangeable conical ground glass joints
5681-1970 General meterological thermometers, liquid-in-glass
5717-1970 Pyknometers
5725-1970 Pyschrometers, unventilated (dry and wet bulb hygrometers)
6017-1971 Thermometers for whirling psychrometers
6052-1970 Glass condensers
6128-1971 Desiccators
6154-1971 Perforated plates for desiccators
6274-1971 Method of calibrating liquid-in-glass
6500-1972 Thermometer for measurement of sea surface temperature
6592-1972 Soil thermometers
7000-1973 General purpose maximum and minimum thermometers
7324-1974 Brix hydrometers
7374-1974 Glass rods and tubing for laboratory glassware
8728-1977 Adjustable range thermometers
8729-1977 Principles of construction and adjustment of volumetric glassware
8787-1977 Principles of design, construction and use of liquid-in-glass thermometers
8897-1978 Tables for calibration and methods of verification of volumetric glassware
9213-1979 BOD bottles
9621-1980 Principles of construction and adjustment of glass hydrometers
10072-1982 Plastics beakers

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	Unit	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	Unit	Symbol
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	Unit	Symbol	Definition
Force	newton	N	1 N = 1 kg.m/s ²
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m ²
Frequency	hertz	Hz	1 Hz = 1c/s (s ⁻¹)
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m ²

INDIAN STANDARDS INSTITUTION

Menak Bhawan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110009

Telephones : 26 80 21, 27 81 21

Telegrams : Manaksantha

Regional Offices:

Western : Novelty Chamber, Grant Road
 Eastern : 5 Chowringhee Approach
 Southern : C. I. T. Campus
 Northern : B69, Phase VII

BOMBAY 400007	37 97 29
CALCUTTA 700072	27 50 90
MADRAS 600113	41 24 42
S. A. S. NAGAR (MOHALI) 160051	—

Branch Offices:

'Pushpak', Nurmohamed Sheikh Marg, Khanpur
 'F' Block, Unity Bldg, Narasimha Rao Square
 Gangotri Complex, Bhadbhada Road, T. T. Nagar
 22E Kalpana Area
 5-6-56C L. N. Gupta Marg
 R14 Yudhisther Marg, C Scheme
 117/418 B Sarvodaya Nagar
 Palliputru Industrial Estate
 Hantex Bldg (2nd Floor), Rly Station Road

AHMADABAD 380001	2 03 91
BANGALORE 500022	22 48 05
BHOPAL 462003	6 27 18
BHUBANESHWAR 751014	5 36 27
HYDERABAD 500001	22 10 03
JAIPUR 302005	6 98 33
KANPUR 208005	4 72 92
PATNA 800013	6 28 08
TRIVANDRUM 695001	32 27